Micropatterning of UV Curable Polymer

NanoInk Inc. NanoFabrication Systems

Introduction

Micropatterning of polymers has utility in several different fields including tissue engineering, cell-cell and cell-surface interaction studies, lab-on-a-chip development, flexible circuit and microlens construction. Common polymer micropatterning techniques include inkjet printing, direct laser writing, microcontact printing and photolithography. Here we describe a new method of printing polymers using tip based nanolithography.

Principles of Nanolithography-Based Polymer Micropatterning

To demonstrate the micropatterning of polymers with tip based nanolithography, we patterned UV curable acrylic based polymers on both glass and SiO_2 surfaces. Several polymers, ranging in viscosity from 80 cps to 25,000 cps, were printed on glass. Although the polymers all demonstrated good print reliability and repeatability at micron scales, deposited polymer droplets exhibited different aspect ratios. The highest-viscosity polymer printed the most consistently over a few thousand spots. All data presented below was obtained using a polymer with a viscosity of ~ 22,000 cps.

We used NanoInk's Nano Lithography Platform (NLP 2000 System) and 1D array of cantilever pens (M-Type) to pattern the polymers. The pens were loaded by directly dipping the cantilevers into polymer droplets and then blotting the cantilevers to remove excessive material. The loaded cantilever "pens" were then employed to print the polymers onto a glass surface. Homogenous arrays of ~3-micron diameter spots were printed over a 2 mm^2 area. The same polymer-filled cantilever pen could print over ten thousand individual spots without being reloaded.

The polymer used to generate the array described above had excellent optical transmission properties and could potentially be used as a polymer microlens, a structure known to have broad utility for optical system applications.

Figure 1 shows optical images of the printed polymer arrays. Arrays of polymers, in which each spot has sub-cellular dimensions, can be used to study the interaction of cells with micro-patterned substrates at the single cell level.

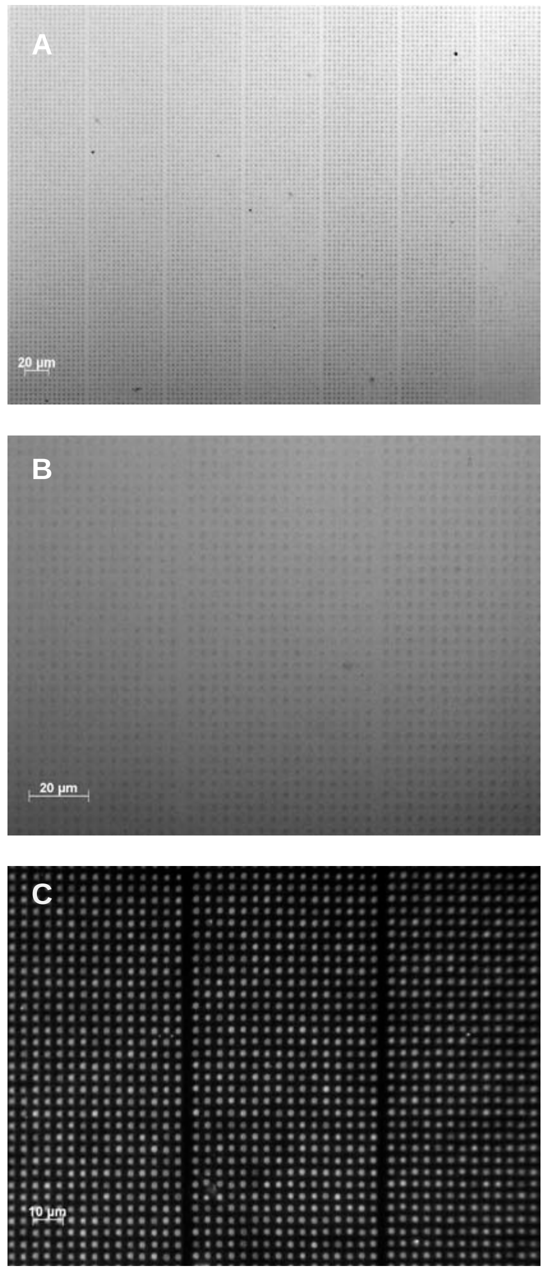

Figure 1. (A) 20x brightfield image of a single run polymer-patterned area on a glass slide. (B) 50x brightfield images of polymer-patterned area. (C) 50x darkfield images of polymer-patterned area.

APPLICATION NOTE

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Printed polymer arrays were cured using UV-irradiation and then imaged by AFM. Resultant data (Figure 2) demonstrates homogenous printing of the polymer, with polymer structures being about 2.5 μm in diameter and 120 nm in height based upon AFM data analysis. The printed spot diameter coefficient of variation was 4% and the spot height coefficient of variation was 3%.

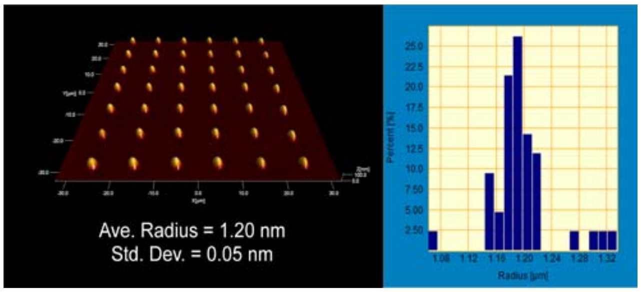

Figure 2. Polymer array AFM data demonstrating homogeneous printing with few outliers

We also demonstrated that the same polymer could be printed on silicon oxide (SiO_2) surfaces with efficiencies similar to those achieved when printing on glass surfaces (Figure 3). However, under identical printing conditions, smaller feature sizes resulted on SiO_2 surfaces than on glass surfaces.

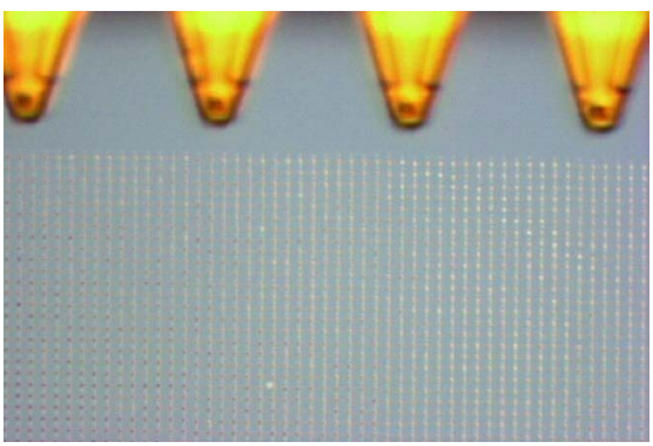

Figure 3. Photograph of NLP 2000 System printing acrylic polymers on a SiO_2 surface.

Conclusion

We have demonstrated that polymer patterns can be printed homogenously and directly onto smooth substrates like glass and silicon wafers. Due to hydrophobicity differences, printed polymer feature sizes are smaller on silicon wafers than they are on glass substrates. High efficiency polymer deposition over a large surface area is possible on both glass and silicon substrates.

NanoInk Products Used

NLP 2000 System
DPN® Pen Arrays: Type M
DPN® Inkwell Arrays: Type M-12MW
DPN® Substrates: Silicon

Learn more about NanoInk products and services at www.nanoink.net. Or call us at 847-679-NANO (6266).